Work and Energy

1) If two cars are identical except for the size of their engines, how will that affect their performance on the highway?

- larger engine could do more work

2) What is the "law of conservation of energy"? When does this law apply?

Energy cannot be created or destroyed
↳ only transformed.
Applies everywhere

3) When work is done on an object, where does the energy used to do the work go?

- transformed to new type
↳ turned into heat, kinetic, gravitational, etc.

4) If a force does not act parallel to the resulting displacement, what is the effect on the work done by the force?

- amount of work done will be less for same output
↳ less efficient!

5) Describe how a non-zero force can act on an object over a displacement and yet do no work.

- if the angle between $\vec{F}$ and $\Delta\vec{d}$ is 90° (perpendicular), that force will do no work on that object

6) A force of 825 N is needed to push a car across a lot. Two students push the car 35 m. How much work is done? [2.9 x 104 J]

$F = 825\ N$
$\Delta d = 35\ m$
$\theta = 0^\circ$

$W = Fd\cos\theta$
$W = 825\ N(35\ m)\cos 0^\circ$
$W = 28875\ Nm$
$W \approx 2.9 \times 10^4\ J$

7) An airplane passenger carries a 215 N suitcase upstairs a displacement of 4.20 m vertically and 4.60 m horizontally. How much work against gravity does the passenger do? [903 J]

$F = 215\ N$
$\Delta d = 4.20\ m$
$\theta = 0^\circ$

$W = F\Delta d\cos\theta$
$W = 215\ N(4.20\ m)\cos 0$
$W = 903\ J$

8) A champion weightlifter raises 240.0 kg a distance of 2.35 m.

i) How much work is done lifting the weights? [5530 J]

$m = 240.0\ kg$
$\Delta d = 2.35\ m$
$W = ?$
$\theta = 0^\circ$

$W = F\Delta d\cos\theta$
$W = -mg\Delta d\cos\theta$
$W = -240.0\ kg(-9.81\ m/s^2)(2.35\ m)\cos 0^\circ$
$W = 5532.84\ J$
$W \approx 5530\ J$

ii) How much work is done holding them above his head? [0 J]

$\vec{\Delta d} = 0$

∴ No work!
↳ 0 J

iii) How much work is done lowering them back to the ground? [-5530 J]

Assume: constant velocity

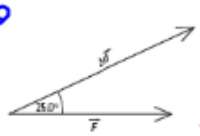
$m = 240.0\ kg$
$\Delta d = 2.35\ m$
$W = ?$
$\theta = 180^\circ$

$W = -mg\Delta d\cos\theta$
$W = -240.0\ kg(-9.81\ m/s^2)(2.35\ m)\cos 180^\circ$
$W \approx -5530\ J$

9) The picture below shows a force of 150 N [0°] acting on an object that moves over a displacement of 25.0 m [25.0°] while the force acts. What is the work done by this force? [3400 J]

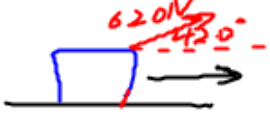
$F = 150N$
$\Delta d = 25.0m$
$\theta = 25.0°$
$W = ?$

$W = F\Delta d\cos\theta$



$W = 150N(25.0m)\cos 25°$
$W = 3398.654201J$
$W \approx 3400J$

10) You pull a sled along a horizontal surface by applying a force of 620 N at an angle of 42.0° above the horizontal. How much work is done to pull the sled 160 m? [7.37 x 10^4 J]



$F = 620N$
$\theta = 42.0°$
$\Delta d = 160m$
$W = ?$

$W = F\Delta d\cos\theta$
$W = 620N(160m)\cos 42°$
$W = 73719.67J$
$W \approx 7.37 \times 10^4 J$

11) A force acts at an angle of 30.0° relative to the direction of the displacement. What force is required to do 9600 J of work over a displacement of 25.0 m? [443 N]

$\theta = 30.0°$
$F = ?$
$W = 9600J$
$\Delta \vec{d} = 25.0m$

$W = F\Delta d\cos\theta$
$\frac{W}{\Delta d\cos\theta} = F$
$F = \frac{9600J}{25.0m(\cos 30.0°)}$
$F = 443N$

$\vec{F} = 443N[25.0°]$

12) A force of 640 N does 12 500 J of work over a displacement of 24.0 m. What is the angle between the force and the displacement? [35.5 °]

$F = 640N$
$W = 12500J$
$\Delta d = 24.0m$
$\theta = ?$

$W = F\Delta d\cos\theta$
$\frac{W}{F\Delta d} = \cos\theta$
$\arccos\left(\frac{W}{F\Delta d}\right) = \theta$

$\theta = \arccos\left(\frac{12500J}{640N(24m)}\right)$
$\theta = 35.5°$

13) A bungee jumper with a mass of 60.0 kg leaps off a bridge. He is in free fall for a distance of 20.0 m before the cord begins to stretch. How much work does the force of gravity do on the jumper before the cord begins to stretch? [1.18 x 10^4 J]

$m = 60.0\,kg$

$\Delta d = 20.0\,m$

$w = ?$

$\theta = 0°$

$W = F\Delta d\cos\theta$

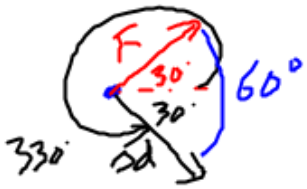
$W = mg\Delta d\cos\theta$

$W = 60.0\,kg(9.81\,m/s^2)(20.0\,m)\cos 0°$

$W = 11772\,J$

$W \approx 1.18 \times 10^4\,J$

14) A force of 850 N [30°] acts on an object while it undergoes a displacement of 65.0 m [330°]. What is the work the force does on the object? [2.76 x 10^4 J]



$F = 850\,N$

$\Delta d = 65.0\,m$

$w = ?$

$\theta = 60°$

$W = F\Delta d\cos\theta$

$W = 850\,N(65.0\,m)\cos 60°$

$W = 27625\,Nm$

$W \approx 2.76 \times 10^4\,J$

Rember, θ is the angle between F and Δd!